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Global Practices and Experiences in Developing a Green Economy amid Financial Crises

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Abstract

Currently, the global community confronts two pivotal challenges such as the rapid expansion of the world population and the consequential escalation of pressure on the environment. Swift and effective mitigation of these challenges necessitates the expeditious internalization of external effects as a primary preventive measure. Therefore, this article aims to analyze the strategies employed by the leading economies, including China, the United States, Korea, and the European Union, to advance their green economies amidst periods of financial downturns. By analyzing the cases of these countries, we explore the implementation of green economy policies and strategies during times of economic downturn, focusing on initiatives undertaken, investments made, and outcomes achieved. The study highlights the varying approaches and responses of different economies to promote green growth, including stimulus packages, policy frameworks, and investment priorities. The collected data underwent a comparative analysis to understand the dynamics of green economic development, such as policy frameworks, investment priorities, stimulus measures, and resultant outcomes. As a result, it is established that the green economy offers a strategic pathway for nations to address pressing challenges, such as economic downturns, by concurrently fostering environmental sustainability and social welfare. The integration of green practices aligns with the overarching goal of achieving sustainable development, wherein economic growth is harmonized with environmental preservation and social inclusivity.

Keywords

Green economy; International economic activity; International competitiveness; Economic security; Financial crisis

Introduction

The global community is confronted with two pivotal challenges, namely the rapid expansion of the world population and the consequential escalation of pressure on the natural environment. Swift and effective mitigation of these challenges necessitates the expeditious internalization of external effects as a primary preventive measure (Kasztelan, 2017). In the intricate landscape of economic dynamics, the intersection of green development and financial crises represents a critical juncture, which demands thoughtful consideration. For example, the rise in temperatures and diseases caused by pollution leads to a deterioration of human capital and a decrease in productivity levels, resulting in economic decline (Bossone *et al*., 2022).

The economic crisis of 2008 catalyzed green growth, prompting governments to swiftly implement 'green' stimulus and recovery plans. For example, in 2009, the American Recovery and Reinvestment Act (hereinafter - ARRA) allocated approximately $90 billion specifically for green investments, including renewable energy, energy efficiency, and clean technology research in the United States (Federal Communications Commission, 2009). This funding helped advance initiatives like weatherizing homes, improving energy grids, and investing in electric vehicles, setting a precedent for green stimulus efforts in the U.S. According to the Department of Energy, ARRA's investments were crucial in increasing wind energy capacity by 60% and solar capacity by nearly 20% from 2009 to 2011. Furthermore, South Korea's Green New Deal allocated around 80% of its $38 billion stimulus package to green projects, making it one of the most environmentally focused recovery plans globally. These investments targeted green transportation, energy efficiency, water management, and the development of green industries. This initiative helped South Korea emerge as a global leader in green technology and significantly increased renewable energy use, aiming to create over 1.5 million jobs by 2020 through green sectors (Technopolis Group, 2016).

These initiatives aimed to tackle environmental concerns while simultaneously fostering green economic growth and employment opportunities. This intersection prompts an exploration into strategies that align environmental sustainability with economic resilience, seeking a harmonious balance between mitigating ecological challenges and addressing the economic ramifications of crises. In this way, economic growth can be enhanced while taking care of natural and human capital and being respectful of the planet's limits. However, it challenged the validity of economic models and policies that had evolved in recent decades (Fedrigo-Fazio and Ten Brink, 2012).

Thus, when compared to the "brown" (or traditional) economy, the green economy does not guarantee higher levels of output and employment (United Nations, 2011). Green economy is defined as the results of improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (Economic Commission for Europe, 2011). Although the term "green growth" is similar to the concept of a green economy, these terms are different in their implementation. The OECD Green Growth Report defines green growth as "promoting economic growth and development while ensuring that natural assets continue to provide resources and environmental services essential to our well-being" (Fedrigo-Fazio and Ten Brink, 2012). Meanwhile, the concept of green growth highlights the significant value placed

on expanding economies quantitatively to support increasing populations, evolving development goals, and poverty alleviation efforts (UNEP, 2011).

Consequently, the green economy and green growth are based on the principle of advancing economic development worldwide. The emphasis lies on the ecologically responsible approach to growth that preserves the delicate balance of planetary ecosystems. At the same time, the concept of the green economy encompasses several paramount challenges that confront contemporary society, including the eradication of poverty, fostering a more harmonious relationship with the environment, mitigating the potential adverse effects of global climate change, and charting a course towards sustainable development (United Nations, 2011).

As articulated by the United Nations Conference on Trade and Development (UNCTAD), the successful transition to a green economy necessitates a concerted effort to address at least four key elements (United Nations, 2011). The first one is the identification of funds for transitional initiatives in developing countries. Second, the establishment of an enabling environment, conducive to private investment, emerges as a crucial factor in providing support to these endeavours. Thirdly, leveraging trade as a supportive instrument for sustainable development is essential, coupled with the imperative to resist the allure of green protectionism. Lastly, the design and implementation of innovative mechanisms for the transfer of green technologies to developing nations stand out as the fourth imperative in navigating this transition effectively.

However, industrialized economies are better equipped to transition to a green economy as compared to developing economies. In other words, they possess more technological, financial, and human resources to realize a low-cost transition to a green economy. Conversely, transition expenses are likely to be higher in developing economies. It is challenging to foresee a transition period where the internalization of social and environmental costs does not, at least initially, result in a decline in real income (Polishchuk *et al*., 2019).

Furthermore, crises of various kinds frequently share similar roots: the accumulation of unsustainable economic imbalances and discrepancies in asset prices or exchange rates, typically within a framework of financial sector distortions and structural inflexibilities that often reveal the unsustainable aspects of the existing economic system (Kuzheliev and Britchenko, 2016). For example, the 2008 global financial crisis was caused by the collapse of the U.S. housing market. Years of unsustainable lending practices, including subprime mortgages, created an economic imbalance in the form of a housing bubble. Distorted asset prices in real estate within a loosely regulated financial sector led to the global economic collapse. Moreover, the Eurozone Debt Crisis of 2010-2012 provides another example. Unsustainable debt accumulation in countries like Greece, Portugal, and Spain led to a crisis when the financial sector's ability to lend was damaged by high public debt levels. The economic imbalances between stronger economies (e.g., Germany) and indebted economies exposed the structural weaknesses of the Eurozone in terms of the inability to adjust currency values or manage debt independently within the currency union.

At the same time, crises can be a catalyst for change, prompting a rethinking of current economic models and policies (Barbier, 2010). In its turn, the green economy, as a paradigm, places sustainability at its core, encompassing diverse sectors such as renewable energy, eco-friendly technologies, sustainable agriculture, and circular economy practices (McKenna *et al*., 2016). Henceforth, directing investments towards the establishment and fortification of a green economy emerges as a strategic approach, considering its explicit emphasis on sustainability and resilience. This approach is discerned as a methodological means to not only reconstruct societies following crises (Knight, 2021), but also to systematically address the inherent vulnerabilities that underpin socio-economic systems (Environment Management Group, 2018).

Learning from past experiences is vital for enhancing resilience in the face of future economic crises or environmental challenges. Analyzing how countries navigated the intersection of economic recovery and green development during the 2008 crisis can contribute to the formulation of more resilient and adaptive strategies for future uncertainties. As the global economy struggled to recover after the financial crisis of 2008-2009, it became increasingly clear that the global economy is in the midst of an economic slowdown. Both the demand and supply sides of the economy were significantly affected by this disruption (Bossone *et al*., 2022). In this regard, this article aims to analyze the strategies employed by the leading economies, including China, the United States, Korea, and the European Union, to advance their green economies amidst periods of financial downturns. This aim stipulated the following research questions:

1) How do the strategies for advancing green economies differ among leading economies, such as China, the United States, Korea, and the European Union, during periods of financial downturn?
2) What specific green economy policies, initiatives, and investment priorities have been implemented by these leading economies to sustain green growth during economic downturns, and what outcomes have they achieved?
3) What key lessons and best practices can be identified from the comparative analysis of green economy responses to financial challenges in different countries?

Materials and Methods

This study adopts a comparative and analytical approach to examine the development of the green economy in the context of financial crises using the example of China, the USA, South Korea, and the European Union. It seeks to understand the dynamics of green economic development, such as policy frameworks, investment priorities, stimulus measures, and resultant outcomes. By systematically comparing these factors across the selected countries, this research seeks to provide a comprehensive outline of the diverse approaches adopted in fostering green economic resilience during times of financial uncertainty.

An in-depth review of scholarly papers, reports from international organizations (OECD, World Bank, UN) and analytical documents on the strategy and policies of the green economy was carried out in order to highlight the impact of financial crises on the implementation of environmentally sustainable economic practices. The study uses data from official sources, such as government reports, economic indicators, national action

plans and initiatives adopted by governments during financial crises. Moreover, incentive packages, investments in green technologies, and environmentally oriented programs are assessed in terms of their impact on employment and economic growth.

Regarding the scope of the analysis, government-related information constituted a vital component of the data collection process. Official government websites and repositories were accessed to gather comprehensive data on green economy policies, stimulus packages, and initiatives implemented by countries such as China, the United States, Korea, and the EU. The information sourced from these official channels encompassed a range of documents, including reports from government agencies, policy briefs, and legislative documents. It is acknowledged, however, that the availability of such data may exhibit variability across countries, and certain information may be confined to official government sources or published reports, potentially influencing the comprehensiveness of the subsequent analysis. Furthermore, to enrich the understanding of green economic development strategies amidst financial crises, this study also incorporated insights from case studies and reports published by reputable international organizations. Papers and research papers from reputable organizations, such as the United Nations Environment Programme (UNEP), World Bank, and International Monetary Fund (IMF) were meticulously reviewed.

The comparative method was used to assess the approaches of different countries to the green economy development during economic downturns. This method facilitates identifying key success factors, barriers, and differences in these approaches. Key aspects such aspects as funding, sectoral priorities, impact on economic sustainability, and environmental outcomes were compared.

Specific cases were analyzed to study successful green economy initiatives during financial crises in each country. In particular, the implemented state policies, innovative approaches to investing in renewable energy sources, effective management of resources, and the response to the challenges of climate change were considered.

On the basis of the obtained results, a set of recommendations is provided for politicians and researchers on the sustainable development of economies during crises, using the experience of leading countries in green economy implementation. The purpose of this review is to extract valuable insights into the diverse experiences of different countries in advancing green growth during periods of financial crises. By leveraging the wealth of knowledge provided by these international sources, this research aims to analyze the multifaceted dynamics associated with the promotion of green economies in the aftermath of financial challenges.

Results

Analysis of the environmental consequences of financial downturns

The global financial crisis of 2008-2009, which was characterized by a confluence of systemic failures in financial markets and a pervasive credit crunch, ushered a profound economic recession that reverberated across the international landscape. The crisis not only underscored vulnerabilities in the global financial system but also brought about a

period of economic contraction that affected a variety of industries (Nazarova *et al*., 2021).

During this tumultuous economic period, marked by fragile financial markets and constrained credit access, a parallel and noteworthy phenomenon unfolded in the realm of environmental consciousness. Public concerns regarding climate change grew significantly. The juxtaposition of these two phenomena, the global financial crisis and the intensification of climate change concerns, defined the socio-economic landscape during that period. On one front, financial market grappled with the aftermath of systemic failures, leading to a significant economic downturn. Simultaneously, an increasing awareness and sense of urgency surrounding climate change issues permeated public discourse, highlighting the interconnectedness of economic and environmental considerations on the global stage (Melnyk *et al*., 2019).

The upsurge in environmental concerns was especially pronounced in the run-up to the 15th Conference of the Parties to the UNFCCC in Copenhagen in 2009. This period witnessed a marked increase in discussions surrounding climate-related issues, with stakeholders from diverse sectors converging to deliberate on strategies to address the impending environmental challenges. The impending COP15 summit served as a catalyst, galvanizing international attention and prompting a reevaluation of global priorities. The discourse surrounding the conference extended beyond traditional environmental circles, permeating political, economic, and societal spheres (Khastagir, 2015).

Hence, the recognition of the interconnectedness between economic recovery and environmental sustainability gained traction during this pre-COP15 period (Nazarova *et al*., 2021). Policymakers and global leaders were compelled to navigate the dual imperatives of mitigating the immediate economic fallout from the financial crisis and charting a course toward a more sustainable, resilient, and environmentally responsible future.

The Copenhagen summit became a crucial juncture where nations convened to negotiate and deliberate on strategies to combat climate change. At the forefront of this significant diplomatic undertaking were key figures including the President of COP15 and Danish Prime Minister, Lars Lokke Rasmussen, the UN Secretary-General, Ban Ki-moon, and the President of the United States, Barack Obama (Khastagir, 2015). Collaboratively, they played instrumental roles in shaping the trajectory of discussions and facilitating the preparatory work that culminated in the crafting of a three-page draft agreement. Drafting was entrusted to a group of national ministers known collectively as the Circle of Commitment. This assembly comprised representatives from diverse geographical regions and included Colombia, Indonesia, Ethiopia, the United Kingdom, Maldives, Grenada, Lesotho, Algeria, Bangladesh, India, China, South Africa, Mexico, and South Korea. It set a foundation for ongoing global dialogue and action to address climate change collectively and comprehensively (Khastagir, 2015).

As we delve into the experiences of different countries in navigating the complexities of implementing green economy measures during times of crisis, it becomes evident that the intersection of economic recovery and sustainable development is both nuanced and dynamic. The following paragraphs illuminate distinctive cases, drawn from the

information discussed, showcasing how diverse nations have approached the integration of green economy principles in response to crises. These cases underscore the pivotal role of sustainability in shaping recovery trajectories and offer valuable insights into the diverse approaches adopted by countries across the globe. Significant green stimulus initiatives were implemented in response to the 2008-2009 financial crisis by several major economies, including the China, US, Korea, Japan, and several member states of the European Union (Jaeger *et al*., 2020).

China experience of green economy

The adoption of green economy principles by China is rooted in its economic development since the early 1970s. Over the past four decades, China's approach to environmental conservation has transitioned from basic "end-of-pipe" environmental protection measures to the integration of sustainable development principles into its overarching strategic development policies (Weng *et al*., 2015).

China was among the early responders to the crisis, unveiling a $586 billion (or 4 trillion yuan) stimulus package in September 2008, with approximately $200 billion allocated for green initiatives (Jaeger *et al*., 2020). The effectiveness of China's 2008-2009 economic stimulus package appears to have been positive, given its appropriate size, well-selected components, and timely implementation. Investments in urban infrastructure, green economy, and improved and targeted social services played a vital role in China's efforts to reduce income inequality and foster a more inclusive growth trajectory (Fardoust *et al*., 2012).

From a fiscal standpoint, China initially benefited from low public debt and a large state budget surplus, allowing for significant fiscal flexibility in implementing an extensive stimulus package. A significant portion of the stimulus package focused on additional infrastructure expenditures, particularly in transportation and energy sectors. Additionally, funding was provided for social projects, especially in the health sector and environmental protection, which were considered to be critical for sustainable growth (Melnyk *et al*., 2019).

Accordingly, China's fiscal stimulus in 2008 amounted to 4 trillion yuan, approximately 12.5% of the country's GDP (Table 1). Over a period of 27 months, the stimulus initiatives and programs were implemented, with about 1.2 trillion yuan coming from the government and nearly 3 trillion yuan directed towards projects led by local governments and the private sector. These efforts were largely financed through loans from state-owned and commercial banks.

Thus, China's stimulus package had two main elements, focusing on infrastructure projects such as railways, roads and urban transport. In the first 8 months of 2009, the total investment in rail, road and mass transit in China reached RMB 1,410 billion, a record high. However, despite being environmentally friendly, some railways were built to facilitate interregional coal transportation.

Following the implementation of these infrastructure projects, both coal and power output in China surpassed their previous peak levels in 2008, starting from June 2009.

Consequently, the country's energy consumption witnessed rapid growth in the second quarter of 2009. This surge in energy consumption can be attributed to the substantial allocation of funds towards infrastructure projects, with approximately 81% of the stimulus funds dedicated to such endeavors. These infrastructure projects, characterized by their heavy reliance on materials such as nonferrous metals, steel, iron, and cement, significantly contributed to increased energy consumption in the country.

Table 1: China's fiscal stimulus in 2008

RMB 4 trillion stimulus package composition	*Total allocation**
Housing guarantees	0.4 trillion
Rural construction	37 million
Saving energy and reducing emissions	21 million
Infrastructure development	1.5 trillion
Social services	15 million
Industrial restructuring	37 million
Rebuilding Wenchuan after a disaster	1 trillion
Total (in RMB)	4 trillion

*All currency units in RMB [*Source:* Yang *et al*. (2024)]

A total of RMB210 billion was earmarked for energy-saving, emission-reducing and environmental engineering projects. This direct investment was anticipated to yield significant benefits, including an estimated saving of approximately 19 million tons of coal annually, equivalent to around 14% of China's total energy conservation in 2010. Furthermore, a portion of the stimulus package, amounting to RMB 80-100 billion, was directed towards nuclear power projects, which were expected to deliver an annual saving of nearly 14 million tons of coal upon their completion. As the sustainability of heavy investment in energy-intensive industries is limited, it was anticipated that the stimulus package would shift its impact on energy consumption in China from negative to positive by 2014.

However, its focus on saving energy, reducing pollution and restructuring industry has indirectly influenced investments in alternative energy. Consequently, there has been a notable increase in investment in large-scale renewable energy power generation projects, alongside a marked rise in investment in the manufacturing of wind and solar power generation equipment. These developments reflect a shift toward greater emphasis on alternative energy sources, spurred by the broader objectives to save energy and reduce emissions as outlined in the stimulus package.

China's stimulus program produced positive results in stimulating and restoring growth. In the first half of 2009, China's urban fixed asset investment increased by 26.5%, up 0.4% year-on-year. Notably, from the second quarter of 2009, China's GDP growth stopped declining and began to rise again. GDP grew by 6.1%, 7.9%, and 8.9% in the second quarter, third quarter, and fourth quarter, respectively (Yang *et al*., 2024). Furthermore, through 2019, China's high-speed rail network, built during the ten years following the financial crisis, displaced about 500,000 barrels of jet fuel per day that would have otherwise been consumed in domestic aviation (Varro *et al*., 2020). This

underscores the impact of China's ambitious and infrastructure-focused stimulus in swiftly restoring the country to a dynamic, green growth trajectory.

China is moving towards holistic and integrated approaches to environmental sustainability in its economic development. In China's green economy concept, eco-industry refers to many environmentally friendly industries. Besides water treatment, air purification, energy monitoring and waste recovery, the Chinese environmental industry has expanded to include environmental protection and ecological conservation goods and services. The environmental industry has become an all-encompassing industry (Weng *et al*., 2015). This evolution reflects a maturation of environmental consciousness and a recognition of the interconnectedness between environmental preservation, social progress, and economic prosperity. As China continues to navigate the complexities of sustainable development, green economy is poised to remain a pivotal driver shaping the country's developmental trajectory and policy landscape in the coming years.

Green stimulus initiatives in the United States

In numerous instances, green stimulus initiatives have demonstrated equal or greater effectiveness in job creation compared to spending on fossil fuels or traditional stimulus measures. The ARRA (Federal Communications Commission, 2009) was created to boost renewable energy and energy efficiency jobs. ARRA, which was passed as an economic stimulus package following 2008-2009 global financial crisis, provided about $800 billion (Varro *et al.*, 2020).

The administration of President Obama referred to the ARRA (2009) as an extraordinary response to a crisis unparalleled since the Great Depression. The ARRA was a multi-pronged approach aimed at modernizing the country's infrastructure, promote energy independence, expand education, provide affordable healthcare, give tax relief, and protect vulnerable people. The specified actions in the act included (U.S. Government, 2009):

- Saving and creating jobs and help the economy recover;
- Provide assistance to those most impacted by the recession;
- Encouraging technological advances in science and health to provide the investments needed to increase economic efficiency;
- Investing in infrastructure that provides long-term economic benefits, such as transportation and environmental protection;
- Stabilizing state and local government budgets to avoid cuts in critical services or tax growth at the state and local level.

During 2008–2009, the United States devoted 12% of its total economic stimulus to green initiatives (Jaeger, 2020), leading global investments in renewable energy at that time. The ARRA allocated approximately $90 billion to the clean energy sector, which was distributed to various sectors through both direct funding and tax-related measures. As shown in Figure 6, under the ARRA, a significant portion of clean energy funding, accounting for 51%, was designated for renewable energy and energy efficiency initiatives. Significant resources have also been allocated to public transport (20 %) and upgrading the electricity grid (12%). Direct spending through 45 investment provisions targeting high-value investment areas to promote a sustainable economy accounted for nearly two-thirds of clean energy funding.

Support for renewable energy under the ARRA entailed the expansion of existing incentives and the establishment of new programs. In particular, it extended the production tax credit for wind and the investment tax credit for solar. A post-implementation assessment of the ARRA by the Obama administration found that the initiative supported approximately 900,000 job-years (the equivalent of full-time, year-round employment) in the clean energy sector from 2009 to 2015. A significant portion of jobs were created in the first few years after the stimulus.

According to the World Resources Institute (WRI), grants totaling $25 billion created an estimated 44,000–66,000 jobs in the wind energy sector and 8,300–9,700 jobs in the solar photovoltaic sector between 2009 and 2013 (Jaeger *et al*., 2020). These grants also supported 4,500-4,900 permanent wind energy jobs and 610-630 permanent solar jobs over a 20- 30 year operational lifespan. Additionally, an estimated 8,000 short-term construction jobs and 500 permanent jobs were Additionally, loans worth $2.5 billion financed five commercial-scale solar plants and one of the world's largest wind farms, creating 8,000 short-term construction jobs and 500 permanent roles. In 2010, the Weatherization Assistance Program (WAP) also played a significant role in supporting 28,000 jobs. In this way, it contributed to a reduction of 7.4 million metric tons of carbon emissions, as the ARR) increased funding for the Weatherization Assistance Program by USD 5 billion.

The State Energy Program, backed by a financial allocation of $3.1 billion, significantly impacted employment by supporting 51,000 job-years from 2009 to 2013. This initiative anticipated to yield substantial long-term benefits, as it is expected to result in greenhouse gas (GHG) emissions reduction by 164 million metric tons of carbon dioxide from 2009 to 2050. These reductions are equivalent to the environmental impact of taking 35 million cars off the roads for an entire year. Moreover, the program achieved $7.7 billion in energy bill savings, contributing to both environmental sustainability and economic efficiency. However, an assessment (Popp *et al*., 2020) concluded that the ARRA contributed to an overall increase in total employment, albeit at a slower pace compared to other stimulus investments. The findings fall in the middle of previous estimations, suggesting just under 15 jobs for every $1m of ARRA environmental investment over time.

A notable outcome of ARRA's green fiscal stimulus was its persistent job creation effects, in contrast to the short-term gains observed in other sectors. However, the most significant benefits were observed among manual workers with higher education levels. There was no increase in the wages for other manual laborers, possibly due to the modest size of the green stimulus, insufficient to counteract the long-term decline in the negotiating power of employees, or possibly low-quality jobs.

The Republic of Korea's integrated approach to green growth

Through a comprehensive approach and the establishment of a central governing body solely dedicated to overseeing green growth initiatives, the Republic of Korea has systematically pursued green growth. The joint initiative mobilized various government departments and engaged stakeholders from various sectors of society. The objective was to effectively execute a multifaceted strategy that aligned with environmental

sustainability goals. In 2009, South Korea's adoption of the National Strategy for Green Growth and the concurrent enactment of the Five-Year Plan for Green Growth were key responses to the global financial downturn. These strategic frameworks served as foundational pillars for South Korea's commitment to integrating green principles into its national development agenda.

The Presidential Committee on Green Growth (PCGG) oversees the national green growth strategy and 5-year plan implementation and exercise an overall guidance of green growth programs at national level. It was formed by merging three organizations: the Presidential Commission on Sustainable Development, the Presidential Commission on Energy, and the Special Task Force on Climate Change. This committee plays a pivotal role in shaping and coordinating the green growth agenda of the nation.

From January 2009 to October 2012, the PCGG has been a proactive force in advancing environmental sustainability in the Republic of Korea. It has diligently organized and conducted a total of 21 regular meetings and 11 policy implementation review sessions. These gatherings have served as dedicated forums for focused discussions, strategic deliberations, and comprehensive assessments. Within its ambit of responsibilities, the committee plays a pivotal role in deliberating on the overarching green growth policies and initiatives put forth by the government. Furthermore, it actively engages with the execution and performance of these plans and policies.

Moreover, a significant facet of the PCGG's mandate involves effective coordination with pertinent central administrative agencies and local governments. This collaborative effort ensures a synchronized approach to green growth initiatives, fostering cohesion and alignment across various administrative levels within the national governance structure. Thus, the PCGG assumes a global perspective by actively participating in the global dialogue on green growth. By engaging with international counterparts and contributing to global discussions on sustainable development, the committee facilitates the exchange of best practices, fosters international collaboration, and positions South Korea as a proactive participant in the global green growth agenda. While the PCGG holds the pivotal role of coordinating and deliberating on green growth policies, its influence on the allocation of financial resources remains indirect. The Ministry of Strategy and Finance retains the authority to determine budgetary allocations, which impact the PCGG's ability to implement and scale its envisioned green growth initiatives.

The government's strategic roadmap for advancing its vision in the realm of green technologies materialized in the form of the Green Technology R&D Master Plan, published in January 2009. In formulating strategic goals, presented in Figure 1, the government meticulously examined prevailing trends and anticipated future trajectories within the field of green technologies. An in-depth analysis encompassed an assessment of global trends, insights into the status of forerunners in the global eco-industry, as well as an evaluation of the domestic capacities and the availability of skilled human resources.

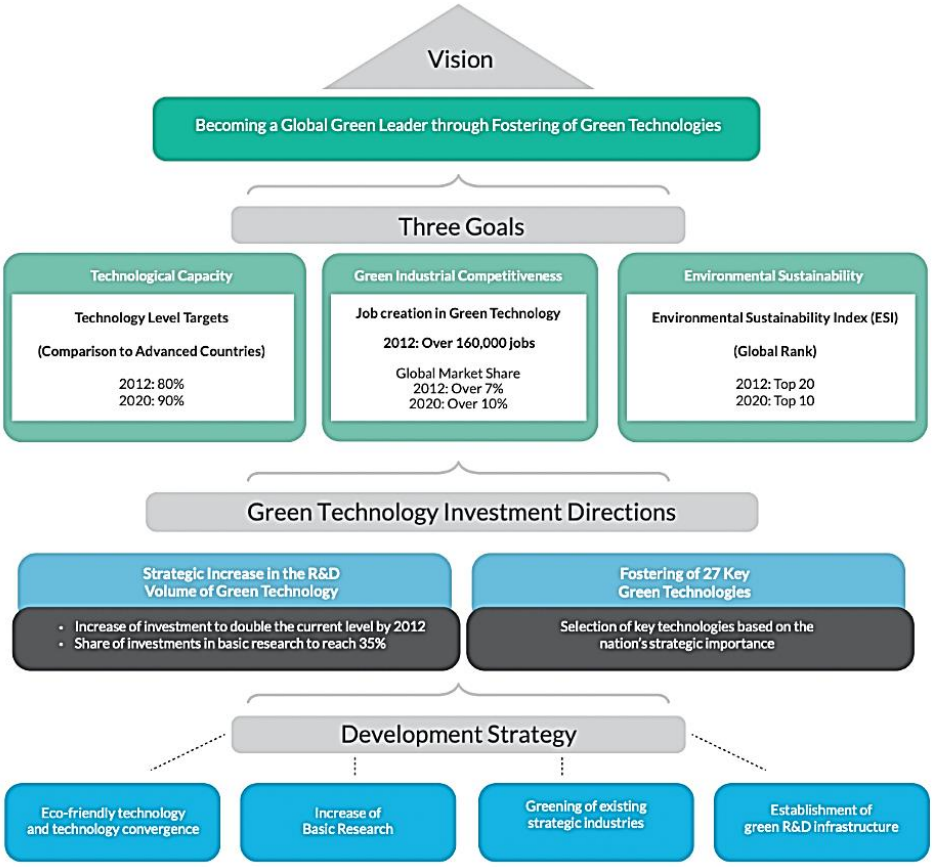
Vision
Becoming a Global Green Leader through Fostering of Green Technologies
Three Goals
Technological Capacity
Technology Level Targets
(Comparison to Advanced Countries)
2012: 80%
2020: 90%
Green Industrial Competitiveness
Job creation in Green Technology
2012: Over 160,000 jobs
Global Market Share
2012: Over 7%
2020: Over 10%
Environmental Sustainability
Environmental Sustainability Index (ESI)
(Global Rank)
2012: Top 20
2020: Top 10
Green Technology Investment Directions
Strategic Increase in the R&D Volume of Green Technology
Increase of investment to double the current level by 2012
Share of investments in basic research to reach 35%
Fostering of 27 Key Green Technologies
Selection of key technologies based on the nation's strategic importance
Development Strategy
Eco-friendly technology and technology convergence
Increase of Basic Research
Greening of existing strategic industries
Establishment of green R&D infrastructure

Figure 1: Korea's green technology research and development vision and objectives [*Source:* Global Green Growth Institute (2015)]

Accordingly, in the formulation of the national GHG reduction targets, the government undertook a meticulous process involving extensive assessments, consultations with relevant experts, and public discussions. This approach aimed to establish a robust social consensus and garner widespread support for the ensuing initiatives. Following the president's announcement in July 2008, signaling the intention to disclose quantified mid-term GHG reduction targets for the period leading up to 2024, an ad hoc team of researchers was assembled. This team, composed of experts from national research institutions specializing in climate science, energy, and economic modeling, was tasked with projecting the Republic of Korea's (ROK) future GHG emissions under various policy scenarios.

The government systematically formulated and presented three distinct scenarios to the public. These scenarios were developed as projections of GHG emissions, taking into account various influential factors. The Business-As-Usual (BAU) emissions projection, a central component of this process, is typically derived from a comprehensive assessment encompassing key variables such as the oil prices, population growth rate, economic growth rate, energy demand, and industrial structure.

These scenarios outlined proposed emission reduction targets: a 21% reduction (Scenario-1), a 27% reduction (Scenario-2), and a 30% reduction (Scenario-3) from BAU levels by the year 2020. Notably, a poll conducted by the PCGG immediately following the announcement indicated that the public demonstrated a favorable inclination towards Scenario 1, whereas experts in fields associated with climate change exhibited a preference for Scenario 2. Meanwhile, an assessment conducted in October 2009, following the successful hosting of the G-20 Summit by the Republic of Korea (ROK), revealed a shift in public sentiment. The majority of the general public now favored Scenario 3, signaling a nuanced evolution in public opinion regarding the preferred GHG reduction trajectory for the nation. Table 2 illustrates the intricate interplay of public perception, expert input, and external events in shaping the trajectory of environmental policies within the Republic of Korea.

Table 2: Scenarios for reducing GHG emissions

Scenario	*Target*	*Criteria*	*Public consultation-based group support*
1	21% (171 million tons reduction from BAU)	Cost efficiency	Industry sector
2	27% (223 million tons reduction from BAU)	International standards	Academic or research institutions
3	30% (244 million tons reduction from BAU)	Developing countries	Environmental and civil organizations

Source: Special Committee on Climate Change (2012)

As depicted by the Global Green Growth Institute (2015) in the Republic of Korea encountered challenges in achieving substantial progress in developing and commercializing green technologies, hindering the realization of planned emissions reductions from the selected measures. Despite having committed to ambitious targets, the inherent limitations of regulatory measures became apparent, with substantive gains being difficult to attain within a compressed timeframe. It is crucial to conduct a thorough examination to determine the appropriateness of the GHG mitigation measures selected by the government and their calculated impacts, given their pivotal role as the basis for setting national reduction targets.

In response to dynamic circumstances, the government has noted rapid transformations within the energy market, particularly concerning technological advancements. The Republic of Korea, designated as one of the most resource-deprived nations, consistently prioritized addressing energy security as a key component of its economic growth plan. Due to resource constraints, the Republic of Korea was compelled to rely heavily on imported energy to meet the ever-increasing energy demands of its economic activity. This reliance on energy imports underscores the critical role energy security plays in shaping the economic strategy and underscores the necessity for strategic planning in managing its energy portfolio. The Republic of Korea adopted the concept of New and Renewable Energies (NRE), which includes a broad range of eight renewables and three new energies:

- Renewable Energy: biomass, solar thermal, wind, small hydro, ocean, photovoltaic, geothermal, and waste;
- New Energy: coal liquefaction and gasification, fuel cell, and hydrogen energy.

Amid an economic slowdown and energy challenges, the Republic of Korea encountered a volatile global renewable energy market after the 2008 financial crisis. In response, adopting the low-carbon, green growth paradigm was seen not as an option but as a national imperative. The energy dilemma carries noteworthy ramifications for other countries, underlining how developing economies must address environmental challenges early in development. Thus, the experience of Korea serves as a pertinent example of the imperative for developing economies to proactively address environmental challenges from the outset of their development trajectories. This necessitates a shift towards sustainable practices and the consideration of long-term resource constraints. In an era dominated by the specter of climate change, the conventional approach of overcoming poverty solely through economic growth rooted in resource-intensive activities and technologies is perceived to have diminished prospects for sustained success.

The successful adoption of green economy as a national agenda is contingent upon robust public support. Recognizing this, the Republic of Korea government strategically emphasized the economic advantages associated with green growth, concurrently highlighting its potential to increase the quality of life through the GHG emissions reduction. This approach aimed to secure public approval by illustrating the tangible benefits and positive impacts associated with embracing a green growth paradigm. A remarkable ideational shift was facilitated by the shift to proactive governance in directly addressing climate change, effectively countering criticisms and fostering a paradigm where green growth has evolved into an immutable political ideology. During this transformative period, low-carbon and clean energy initiatives have gained widespread acceptance, being recognized not merely as suitable policies but exemplifying as a best practice.

Moreover, the explicit articulation of the agenda item related to the promotion of a green lifestyle within the Republic of Korea's Five-Year Plan for Green Growth, termed as the "green revolution of life practices" in Korean, underscores a deliberate and strategic approach towards encouraging transformative changes in individuals' lifestyles. The choice of the term "revolution" carries a profound connotation, signifying a call for transformative changes in people's lifestyles. This deliberate framing challenges conventional unsustainable practices, emphasizing the need for a fundamental shift towards a sustainable lifestyle. In order to extend its reach to a broader audience, it is imperative to promote the sense of social responsibility and personal fulfillment driven by it as a social trend.

Despite having a favorable foundation upon which to cultivate robust societal momentum, the government has encountered challenges in fully realizing its initial expectations concerning the promotion of a green lifestyle. A persistent obstacle in this endeavor is the deficiency in effective promotion and communication with the public, impeding the implementation of various government policies and programs in the Republic of Korea. Addressing this deficiency is paramount for ensuring the effective uptake of environmentally conscious behaviors and facilitating the attainment of the government's objectives in fostering a sustainable and eco-friendly way of life.

Integration of economic, environmental, and social considerations in the EU's countries

The crisis that commenced in 2008 exerted widespread impacts on many countries. In response, nations directed their policy efforts to cope with the crisis and develop incentive programs to revitalize their financial systems. The EU initiated the Economic Recovery Plan in November 2008 with the objective of stimulating demand, restoring shattered confidence, and promoting employment. In conjunction with this plan, the EU proposed smart investment proposals focusing on skills enhancement and technological advancements aimed at fostering long-term economic development.

In this context, the EU policies and actions for the period of 2009–2010 were formulated, taking into account not only the economic dimensions of the crisis but also its environmental and social ramifications. These initiatives aimed to tackle the multifaceted problems posed by the crisis and chart a course towards comprehensive recovery, ensuring the integration of economic, environmental, and social considerations in the EU's strategic response.

The European Economic Recovery Plan was built around two primary pillars, underpinned by a fundamental guiding principle (Commission of the European Communities, 2008). The first pillar is designed to stimulate demand and boost confidence by injecting a substantial amount of purchasing power into the economy. The Commission proposes an immediate budgetary impulse totaling €200 billion (being equivalent to 1.5% of GDP), emphasizing the urgency of this measure to bolster demand while adhering to the principles of the Stability and Growth Pact. The second pillar emphasized the need to focus short-term actions on improving Europe's long-term competitiveness. The Plan delineates a comprehensive program focusing on smart investment strategies. These smart investments encompassed targeted allocations towards developing requisite skills for future demands, investing in energy efficiency initiatives to create jobs and conserve energy, clean technologies, and infrastructure to promote sustainability. Of the €200 billion earmarked, 13.2% was allocated to making the world greener. Of this, 75% was directed toward improving the energy efficiency of buildings, 20% to railways, and 5% to vehicles. Moreover, more than two-thirds of the 200 billion euros earmarked for climate action in the economic stimulus plan were allocated to energy efficiency. As shown in Figure 2, the largest share was invested in developing energy-efficient buildings, followed by networks and low-carbon vehicles.

Similarly to Korea, the EU’s eco-investments are part of a well-developed strategy to become a leader in clean energy technologies, despite relatively modest green stimulus spending (Ladislaw and Goldberger, 2010). Europe's green stimulus may appear modest compared to the substantial stimulus projects undertaken by China, the United States, and South Korea. However, this discrepancy largely stems from Europe's significant prior renewable and energy efficiency investments, as well as its well-established clean energy technology manufacturing sector. Consequently, the impact of green investment policies has been notable, with each dollar invested in green initiatives yielding significant returns in terms of GDP growth. At the national level, every $1 in green investment is estimated to boost GDP by approximately $0.60 to $1.10, while at the European level, this impact has been even more pronounced, reaching up to $1.50 (Jaeger *et al*., 2020).

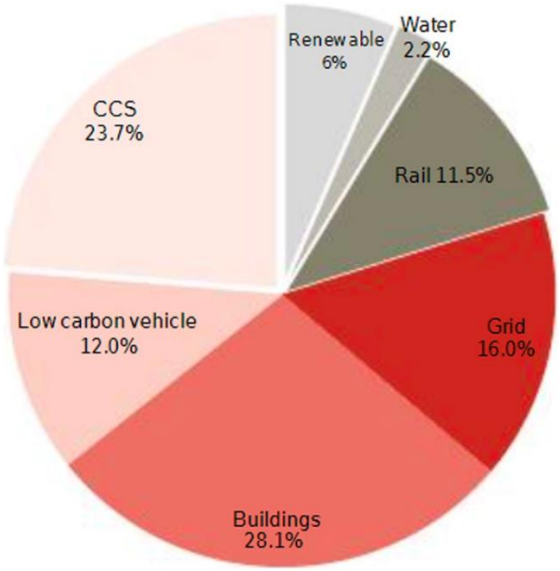

Figure 2: EU green incentive expenditures distribution [*Source:* Mentes (2023)]

The focus on green initiatives varied across countries, with distinct strategies adopted by individual Member States. For instance, Germany incentivized the purchase of lower emissions vehicles, whereas France prioritized investments in energy efficiency and public transport infrastructure (Ladislaw and Goldberger, 2010). Among the Member States, Germany implemented the largest fiscal recovery program within the EU. Roughly 13% of the $105 billion stimulus package in Germany went toward green investments (Barbier, 2015). The ambitious EUR 81 billion (equivalent to USD 104.8 billion) plan comprised a combination of tax reductions and strategic investments in infrastructure and climate change initiatives (Energy Tracker Asia, 2020).

The building refurbishment initiative, with an allocation of €3.3 billion (equivalent to $4.6 billion), emerged as one of the most substantial programs within the stimulus framework. An analysis conducted prior to the implementation of this initiative projected that the investment in building refurbishment would be recouped through reduced energy costs while simultaneously generating an estimated 25,000 jobs within the manufacturing and construction sectors (Meyer-Ohlendorf *et al*., 2009). Furthermore, Germany introduced a €5 billion (approximately $7 billion) vehicle scrappage scheme as part of its stimulus measures. While this initiative successfully stimulated the automobile industry, it also resulted in an unintended consequence of increased emissions.

The allocation of France's stimulus plan towards green measures has been debated, with estimates ranging from 8 to 20 percent of its total €26 billion (equivalent to $34 billion) French Economic Revival Plan (Jaeger *et al*., 2020). Within this stimulus framework, investments in green initiatives encompassed a range of sectors including solar photovoltaic (PV) technology, building efficiency enhancements, and railway infrastructure improvements. However, alongside these green investments, a portion of the stimulus was directed toward upgrades of fossil fuel plants and road infrastructure projects.

Furthermore, in response to the economic downturn, the EU introduced three distinct initiatives targeting sectors significantly impacted by the crisis, namely the construction, automotive, and manufacturing sectors. These programs, namely the Green Vehicle Initiative, the Energy-efficient Buildings Initiative, and the Future Factories Initiative, were specifically tailored to address the challenges faced by these sectors. The overarching objective of these initiatives was to promote the adoption and integration of green technologies, enhance energy efficiency standards, and mitigate carbon emissions across the targeted sectors. By fostering the deployment of sustainable practices and innovative solutions, the EU sought not only to bolster the resilience of these industries but also to advance its broader environmental sustainability agenda.

In this regard, the EU's emphasis on green growth has continued in recent years, with the adoption of the European Green Deal in 2019, which aims to transform the EU's economy into a more sustainable and eco-friendlier one by 2050 (Hedberg and Šipka, 2022). Moreover, the EU established ambitious objectives aimed at curbing greenhouse gas (GHG) emissions and accelerating the adoption of renewable energies. The EU's ambitious target to reduce GHG emissions by at least 55% by 2030 underscores its steadfast commitment to combating climate change and fostering the movement towards a more sustainable and environmentally conscious economy.

Discussion

Our study highlights the critical implementing green stimulus measures is insufficient for achieving comprehensive economic recovery. Each nation incorporated within its stimulus package a diverse range of incentives aimed at fostering short-term growth, encompassing initiatives such as tax reductions, expanded unemployment compensation and outright grants to states and municipalities (Ivashchenko *et al*., 2018). However, the efficacy of green investments in driving economic growth varies significantly, necessitating careful prioritization of initiatives that deliver optimal environmental and economic benefits.

Certain allocations towards green investments exhibit a greater capacity to stimulate economic growth compared to others. Therefore, it is imperative for policymakers to discern and prioritize those green investment avenues that offer optimal potential for bolstering economic recovery and fostering sustainable growth trajectories. By strategically allocating resources towards the most impactful green initiatives, countries can effectively leverage their stimulus packages to achieve both environmental and economic goals.

However, the definition of "green" is subjective and varies by interpretation. Green stimulus projects encompass a broad spectrum of initiatives, from clear investments in renewable energy and infrastructure to more subtle categories such as expenditures on waste and water infrastructure, modernizing the electric grid, and improving transportation. However, there exists criticism regarding the allocation of stimulus funds, with concerns raised about the insufficient allocation towards green investments.

Therefore, to expedite green investments, some countries have opted to relax environmental restrictions and guidelines, prompting debates over the prioritization of

environmental sustainability versus short-term economic gains. It is essential to discern that not all green investments are created equal, and critical evaluation is necessary to ascertain their efficacy. For instance, transportation infrastructure projects can only be deemed "green" if they demonstrably improve upon the environmental impact of alternative transportation options.

Beyond transportation, it is crucial to evaluate the long-term lifecycle impacts of such projects, including emissions from construction, maintenance, and eventual decommissioning. Similarly, renewable energy initiatives should be assessed not only for their immediate benefits in reducing carbon footprints but also for their resource use, such as the mining and disposal of rare earth elements required for solar panels and batteries. Urban development plans branded as "green" should undergo scrutiny to ensure they incorporate sustainable design principles that minimize energy consumption and foster biodiversity. Furthermore, the social equity aspects of green investments demand careful consideration, as projects should provide inclusive benefits without disproportionately disadvantaging marginalized communities.

Moreover, the environmental damage caused by other facets of the stimulus package may offset the benefits of green investments (Polishchuk *et al*., 2019). Therefore, a detailed approach is imperative in evaluating the overall environmental benefits and efficacy of stimulus spending, ensuring that green investments are strategically prioritized and harmonized with broader environmental objectives.

Thus, the introduction of economic incentives aimed at developing green economy has proven to be effective. Just as during the financial crisis of 2008, many countries attempted to stimulate economic recovery through green stimulus measures, similarly, governments imposed a scope of restrictions as a result of the COVID-19 outbreak, aimed at containing the spread of the virus and alleviating its socio-economic impact. Consequently, the implementation of green economy during the 2008 financial crisis and the introduction of restrictions amid the COVID-19 pandemic exhibit notable similarities in their approaches, despite the differing contexts of these crises. As the World Resources Institute (WRI) noted, the Great Recession of 2008 was triggered by domestic financial situation (Jaeger *et al*., 2020). At that time, the economy had an “output gap” between what the economy could produce and what the economy produced; the economy remained healthy, but the credit markets froze. By contrast, the COVID-19 crisis was both health and economic. It was triggered by the pandemic, which in turn caused a significant reduction in supply and demand.

Both periods witnessed a concerted effort by governments and policymakers to address the economic downturn while simultaneously advancing environmental sustainability objectives (Jaeger, 2020). During 2008-2009, the United States, South Korea, and China allocated significant funds towards green stimulus initiatives, yet their commitments in response to COVID-19 have been comparatively lower. Conversely, the EU economies, such as Germany and France, signaled intentions to allocate substantially more towards green stimulus efforts than during the financial crisis 12 years ago.

However, even in the leading countries, the green stimulus response to COVID-19 has been lower as a percentage of total stimulus compared to the Great Recession. Of

particular concern are the responses of the United States and Japan, where governments have not prioritized sustainability to the same extent. During the 2008-09 financial crisis, the US spent 12 percent of the overall stimulus package on green initiatives, including significant investments in renewable energy. However, as of November 2020, less than 1 percent of the $3trn coronavirus economic stimulus package went to green initiatives. Likewise, Japan spent 6 percent of their financial crisis stimulus on green measures, but essentially none of their $2trn economic stimulus package (Jaeger, 2020).

Accordingly, countries have varying degrees of success in implementing their fiscal stimulus plans. The most successful are likely to be the ones with effective policy incentives and economic structures that will keep driving future green investment when the stimulus programs end. Improving both economic and environmental policies and programs are required to promote economic growth and address climate change through increased transparency on stimulus packages and further analysis of country policies (Levchenko *et al*., 2021).

The concepts of green economy and green growth are considered central to the sustainable development plans. While green growth describes economic expansion that is consistent with environmental protection and social inclusion, green economy describes an economic framework that prioritizes environmental sustainability and social well-being (Ovsak *et al.*, 2024). Together, these principles emphasize social equity and environmental resilience, such as adapting to climate challenges while advocating for a transition to more sustainable production and consumption. The adoption of policies aligned with green economy and green growth can be vital in advancing sustainable development objectives, concurrently fostering the emergence of novel employment prospects and enhancing societal well-being.

Hence, green economy offers a strategic pathway for nations to address pressing challenges, such as economic downturns, by concurrently fostering environmental sustainability and social welfare. The integration of green practices serves as a pragmatic response to the dual challenges of economic recovery and environmental stewardship. During crises, the pursuit of green economy components aligns with the overarching goal of achieving sustainable development, wherein economic growth is harmonized with environmental preservation and social inclusivity. Resilience and adaptability in the context of green practices are evident in the ability of ecosystems, communities, and technologies to withstand crises and adapt to changes. For instance, renewable energy sources such as solar panels and wind turbines provide electricity even during natural disasters, ensuring the continuity of critical infrastructure. In agriculture, sustainable practices like crop rotation and agroforestry protect soil from degradation and reduce dependency on favorable weather conditions. Urban environments benefit from green roofs and parks, which mitigate flood risks during heavy rainfall and reduce urban heat island effects. Adaptability is showcased through innovations such as energy-efficient retrofitting of buildings, enabling them to respond to climate challenges, or circular economy models, where waste becomes a resource, easing the impact of supply chain disruptions. Even transportation systems, including electric vehicles and bike-sharing programs, evolve to meet the demands of growing cities (Levchenko *et al*., 2021). These approaches create a robust foundation for long-term sustainable development and the capacity to address unforeseen challenges.

In recent years, several of leading economies implemented significant stimulus packages in response to the global financial crisis. Many of them included a significant green component. Approximately 90 percent of the stimulus expenditures during the global financial crisis was allocated by the following five economies: China, the US, South Korea, Japan, and the EU. In 2008, China initiated a substantial stimulus package totaling 4 trillion yuan (approximately $586 billion USD) to mitigate the adverse impacts of the financial crisis. A significant segment of China's stimulus funds was designated for green investments, encompassing infrastructure development, including the construction of railways, highways, and transportation. Significant resources were also allocated to energy-saving, emission-reducing and environmental projects (Melnyk *et al.*, 2019).

Similarly, in the US, the ARRA was the primary economic stimulus package in response to the global financial crisis of 2008-2009. Its total budget was approximately USD 800 billion. The ARRA included substantial investments in green sectors such as renewable energy, energy efficiency, and environmental conservation. Funds were allocated for various initiatives, including renewable energy projects, weatherization programs, green infrastructure development, and research and development in clean energy technologies. Specifically, the ARRA supported approximately 900,000 person-years of employment in the clean energy sector between 2009 and 2015, with a significant portion of the jobs created in the early years after the stimulus (Jaeger, 2020).

In parallel, South Korea responded to the financial crisis by adopting the 5-Year Plan for Green Growth and the National Strategy for Green Growth in 2009. The country prioritized investments in renewable energy, energy-efficient technologies, eco-friendly infrastructure, and green innovation to foster economic recovery and sustainable development. Since its establishment in January 2009, the PCGG was instrumental in driving environmental sustainability initiatives in South Korea (Fedrigo-Fazio and Ten Brink, 2012).

Furthermore, the EU also launched the Economic Recovery Plan in 2008 to help stimulate demand, restore trust and bolster employment following the financial crisis. A notable portion, equivalent to 13.2% of the earmarked €200 billion budget, went for green investments. 75% of them were channeled towards enhancing the energy efficiency in the building sector, with 20% allocated to railways, and the remaining 5% allocated to vehicles. These initiatives underscored the commitment of these nations and regions to prioritize economic recovery through green investment strategies during the 2008 financial crisis (Commission of the European Communities, 2008).

Indeed, while green stimulus measures can provide a considerable increase in the economy and environmentally sustainable projects, they alone cannot address the complex economic and ecological challenges facing the world. Although they can offer momentum during times of weak financial markets and limited private investment. It involves investments in clean energy industries to bring about an overall recovery. Transitioning to a low-carbon economy demands a comprehensive, long-term approach supported by the right policy framework and sustained investment. While green stimulus initiatives play a crucial role, they are just one component of the broader strategy needed to address environmental challenges effectively (Mazaraki *et al.*, 2023).

Like other aspects of stimulus bills or the green movement, green stimulus measures face challenges and controversies. However, the urgent necessity to create jobs, stimulate economic revival, and develop promising eco-friendly industries, while tackling burning environmental issues has elevated the importance of green stimulus as a strategic political aim. Nevertheless, it is essential to acknowledge that it is still early to fully evaluate the success of green stimulus spending. More comprehensive transparency and analysis of these initiatives are necessary to assess their true effect on the environment and the economy.

Finally, public perception plays a crucial role in developing green economy strategies during crises. Thus, when public support for environmental action is high, governments are more likely to include green initiatives in economic stimulus packages. For example, during the 2008 financial crisis, strong public awareness of climate change led many governments to prioritize green projects in recovery plans as a dual solution to economic and environmental issues. Hence, public support can drive policies toward investment in renewables, energy efficiency, and sustainable infrastructure as part of recovery efforts. Moreover, public perception that emphasizes environmental responsibility pressures companies to align with green practices. For instance, during recent crises, investors have directed funds toward green bonds and sustainable companies, driving green growth when traditional sectors are struggling. In addition, public support can be crucial in driving the structural changes necessary for developing green economy. For example, the use of low-emission transportation and renewable energy infrastructure requires substantial shifts. Public support of these initiatives makes it politically viable for governments to invest in long-term sustainable growth solutions rather than reverting to traditional high-carbon industries.

Conclusion

Green economy and green growth are key elements of sustainable development strategies as they combine economic growth with environmental sustainability and social inclusion. The world's leading economies, such as China, the United States, South Korea and the EU, have made significant investments in green projects during global financial crises, which prompted economic recovery and environmental transformation.

Moreover, green stimulation has demonstrated effectiveness in creating jobs and developing new technologies. However, its full impact needs further analysis. Thus, key lessons learned from the analysis of this experience can help governments and researchers develop more adaptive and sustainable approaches to addressing economic and environmental challenges in the future. Future studies could focus on developing metrics to evaluate the effectiveness of green stimulus programs in achieving low-carbon transitions and their impact on reducing economic vulnerabilities. Analyzing the role of international cooperation in financing and implementing green initiatives, particularly in developing economies, would also contribute to understanding how global partnerships can drive sustainable development. By addressing these research areas, scholars and policymakers can work together to refine strategies for leveraging the green economy as a tool for overcoming economic crises and achieving long-term sustainability.

Therefore, green economy can be a long-term strategy to overcome economic crises because it ensures sustainability by integrating environmental and social goals. While financing green initiatives is an important component of stimulus programs, there is a need to continue developing policies and supporting investments to transition to a low-carbon economy, which will be the basis for sustainable economic development in the future.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*	*Author 5*
Conceived and designed the research or analysis	Yes	Yes	No	No	No
Collected the data	Yes	Yes	No	Yes	Yes
Contributed to data analysis & interpretation	No	No	Yes	No	No
Wrote the article/paper	Yes	Yes	Yes	Yes	Yes
Critical revision of the article/paper	Yes	Yes	Yes	No	No
Editing of the article/paper	Yes	No	No	No	No
Supervision	Yes	Yes	No	No	No
Project Administration	Yes	No	No	No	No
Funding Acquisition	No	No	No	No	No
Overall Contribution Proportion (%)	30	20	20	15	15

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Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

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The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

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(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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